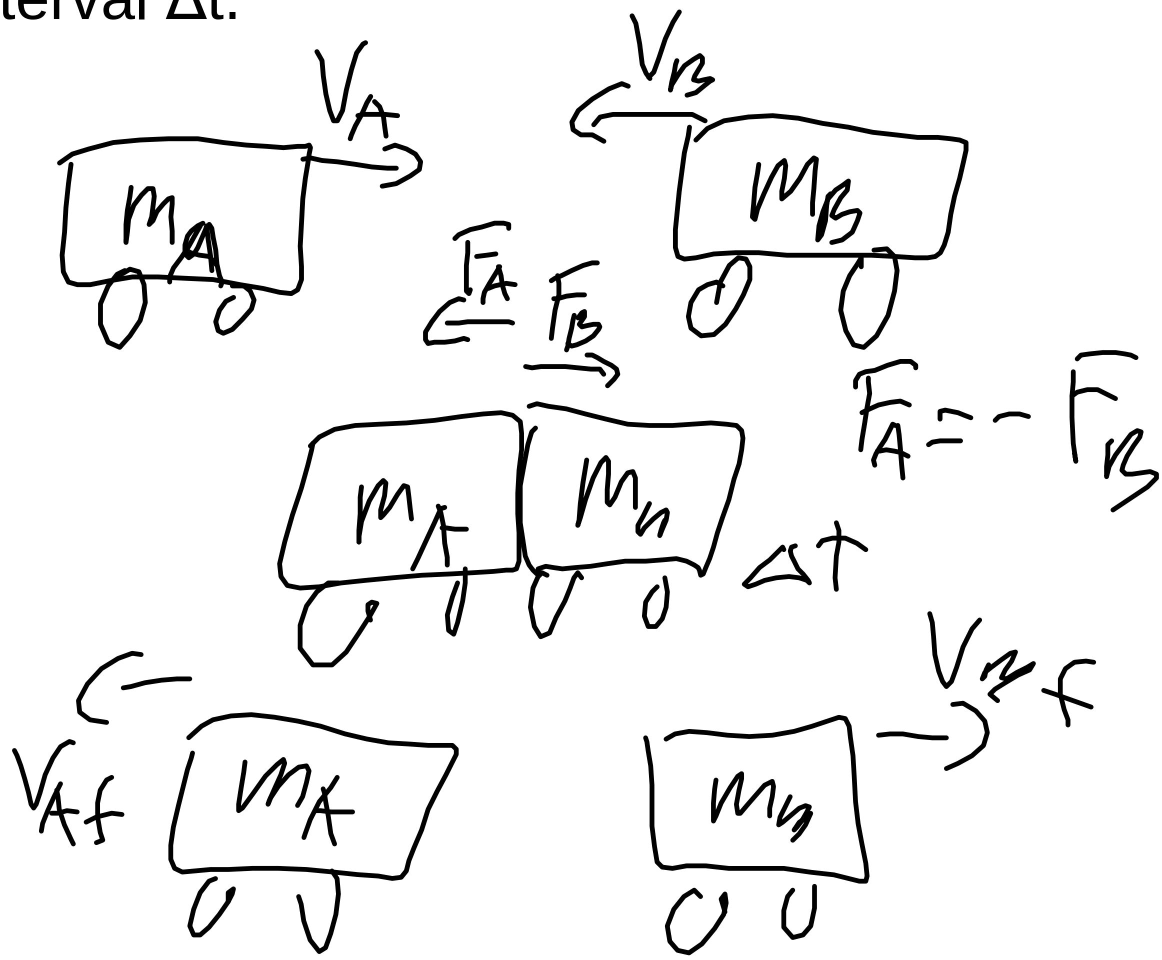
Tuesday, December 05, 2017 10:19 AM

Law of conservation of momentum

If an object with mass, m_A is moving with velocity v_A and collides with an object with mass m_B moving at velocity v_B,
while in contact, they both experience equal and opposite forces, F_A and F_B over the same time interval Δt.



total momentum of the system

Before During after

$p_t = p_A + p_B$

$=m_Av_A+m_Bv_B$

$F_A\Delta t=-F_B\Delta t$

$$\Delta p_A = -\Delta p_B$$

$$p_{Af} - p_A = -(p_{Bf} - p_B)$$

$$p_{tf} = p_{Af} + p_{Bf}$$

$$= m_A v_{Af} + m_B v_{Bf}$$

$$p_{Af} + p_{Bf} = p_A + p_B$$

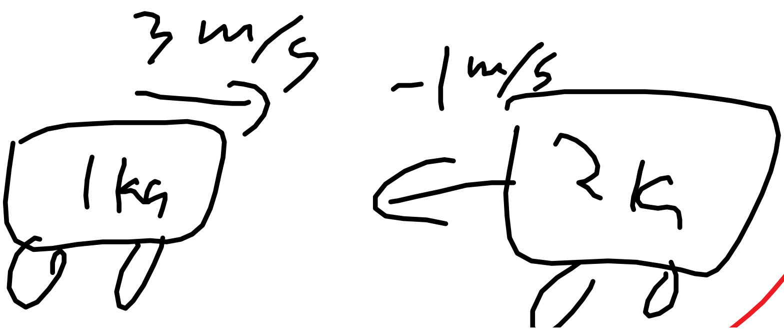
$$p_{tf} = p_t$$

when objects collide or push apart, the total momentum of the two objects before = total momentum after. Assuming no external forces. (closed, isolated system)

eg. A 1.0 kg cart moving at 3.0 m/s collides with a 2.0kg cart moving at -1.0 m/s.

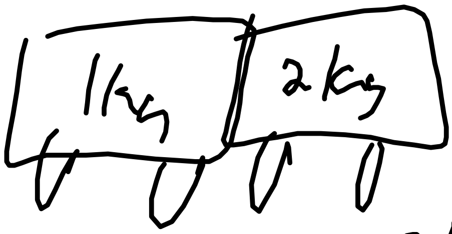
a) what is the momentum of the two carts?
b) if the carts collide and stick together, what is their velocity?
c) if the carts collide and bounce off, so that the 1.0 kg cart moves at -2.0m/s, what is the speed of the 2.0 kg cart after?

a) p=mv = 1.0kg x 3.0 m/s = 3.0 kgm/s
   p= 2.0kg x -1.0m/s = -2.0 kgm/s
b) big idea total momentum is conserved.



P_T = 3.0 kgm/s
− 2.0 kgm/s

$P_T = P_A + P_B$ $\qquad$ $1.0\,kg\,m/s$



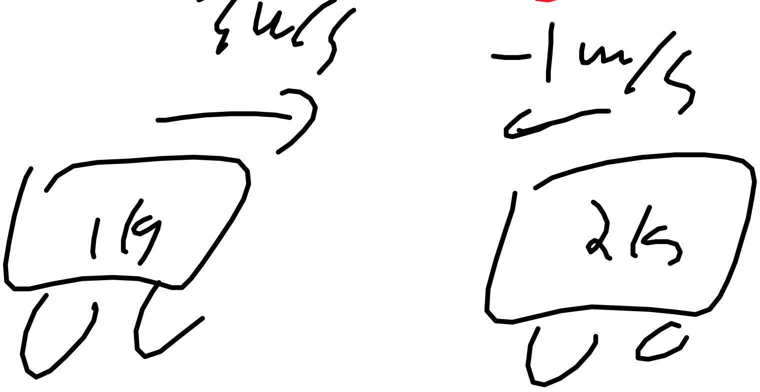
$m = 1 + 2 = 3\,kg$

$P_{Tf} = m_T v = P_T$

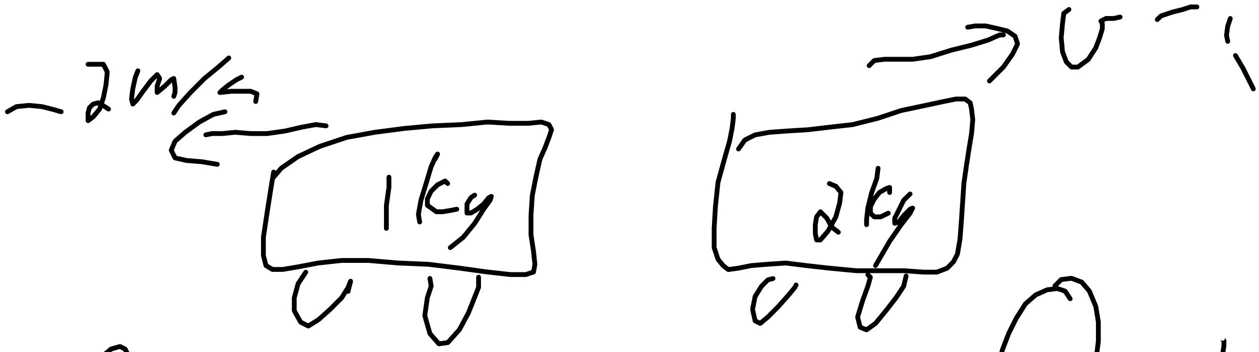
$3\,kg\,v = 1.0\,kg\,m/s$

$v = 0.33\,m/s$

c)



$P_T = 1\,kg\,m/s$



$P_{Tf} = 1\,kg \times (-2\,m/s) + 2\,kg\,(v) = 1\,kg\,m/s$

$2\,kg\,v = 3\,kg\,m/s$

$v = 1.5\,m/s$